



Photograph by Scott Gende

**Figure 1.** At left, the steamship Queen in front of the Muir glacier, circa 1890. Visitation to Glacier Bay by these ships preceded the establishment of the park by a century. Above, Holland America's Amsterdam enters the park in 2005.

# Understanding How Cruise Ships Affect Resources and Visitor Experiences in Glacier Bay National Park and Preserve

By Scott M. Gende

Visitation by cruise ships to Glacier Bay has a dynamic history, dating back to regular visits by steamships in the early 1880s (*Figure 1*). These “cruises,” which may have represented the onset of tourism in Alaska, frequented the area in low but regular numbers until 1899 when an inordinate amount of ice, calved from the surrounding glaciers as a result of an earthquake, restricted visitation to the bay for years afterwards. Ship visitation resumed in the early 1900s and continued at low levels until the 1960s when visitation began to rise, mirroring the growth of the cruise industry worldwide. Cruise ships now provide the primary means of visitor access to the park; in 2007 over 400,000 people—nearly 95% of total park visitation—visited Glacier Bay aboard cruise ships (*Figure 2*).

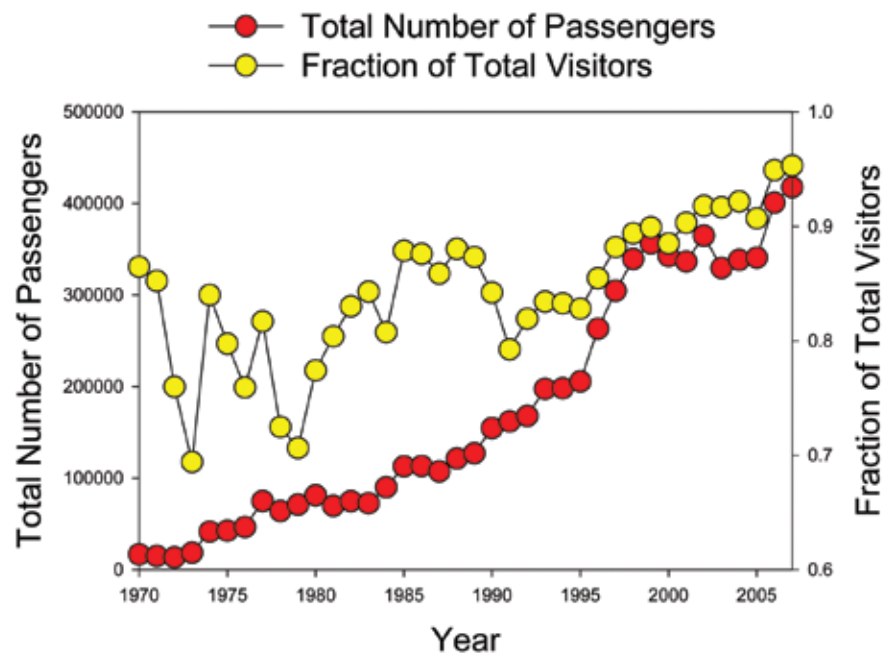
Cruise ships provide a number of benefits to visitors and park management. The vessels bring a diverse group of visitors to Glacier Bay, including those

whose personal travel preferences, physical capabilities, and sheer numbers might otherwise preclude their experiencing the park. Cruise ships also support natural and cultural interpretive programs, with NPS rangers and Hoonah Tlingit cultural interpreters educating a large number of passengers with onboard presentations and commentary (*Figures 3-4*). Since 1996, cruise industry revenue provided to the park through passenger fees has supported these and other programs with an average of over \$1.3 million dollars annually. From a visitation standpoint, cruise ships provide an efficient means of maximizing both visitation and interpretive efforts in the park.

Yet, maximizing the numbers and diversity of park visitors through increased cruise ship access could affect park resources and visitor experience in many ways. Cruise ships are essentially floating cities with potential to affect the biological, physical and socio-cultural resources in the park. For example, an oil spill as a

result of an accidental grounding by a cruise ship would have the potential to pollute park waters with long lasting effects. Stack emissions (engine exhausts) continually release air pollutants that may harm biota, or interfere with wilderness experiences of other visitors (*Figure 5*). Cruise ships may also directly influence the behavior or survival of wildlife in Glacier Bay. Close encounters between ships and humpbacks whales, an endangered species, are common (*Figure 6*), and a number of fatal collisions have been documented in Alaska, including in Glacier Bay. Disturbance to wildlife, such as harbor seals in Johns Hopkins Inlet, also remains a concern for park management (*Figure 7*).

Considerable uncertainty exists regarding the extent and significance of these impacts, and whether or to what degree they degrade park resources. Although a myriad of potential impacts have been suggested, few have been thoroughly investigated. The Vessel Quotas and Operating Restrictions Final Environmental Impact Statement (FEIS)



**Figure 2.** Trends in the number of visitors to Glacier Bay over the past 25 years, and the proportion of those visitors arriving aboard cruise ships.



**Figure 3.** Cruise ships bring hundreds of thousands of visitors to Glacier Bay every year, providing access to the tidewater glaciers and other resources in the park.



**Figure 4.** An NPS interpretive ranger answers questions from passengers on the front deck of a cruise ship. Cruise ships provide a means for visiting the park for many whose physical capabilities would otherwise limit their access to the park.

Data: Glacier Bay National Park and Preserve

of 2003, which outlines conditions and quotas of virtually every vessel type that enters Glacier Bay, reflects this uncertainty. Although the FEIS specifies that the daily maximum number of cruise ships entering the park will remain at two, it provides for a possible 32% increase in seasonal use days for the ‘prime’ June–August season (92 days), from 139 ship entries to 184 (two ships per day, every day). Any increase would occur at the discretion of the park superintendent, who may change the quota annually as needed to protect park values and purposes [per 36 CFR 13.1160 (b)].

To help better understand how seasonal increases in cruise ship entries may influence park resources, a Science Advisory Board was convened in the summer of 2004 at the request of the superintendent of Glacier Bay. The objectives of this independent panel were to identify what impacts might occur should seasonal entries in ship traffic increase and to recommend studies that could provide insight into the existence or extent of these impacts. The board membership, which is still active, includes ecologists, engineers, biologists, social scientists, and a subsistence coordinator from a number of state and federal agencies.

At meetings throughout 2004 and 2005, the board debated the potential impacts of a seasonal increase in ship traffic and identified information gaps that could be addressed by research or monitoring. These meetings included a day visit aboard Holland America’s *Volendam* to view waste reduction and processing,

water treatment, and bridge and other ship operations. In September 2005, the board submitted a report to the park superintendent (*Glacier Bay Vessel Management Science Advisory Board 2005*) recommending against immediate increases in seasonal use days, concluding that existing information was insufficient to allow for an informed assessment of the impacts to park resources if increases in cruise traffic were to be allowed. The board recommended specific research and monitoring efforts that could be implemented to address information gaps.

At the superintendent’s request, the board also provided suggestions regarding the relative priority and sequencing of studies. Recognizing the difficulty of attributing cruise ship impacts in an inherently variable ecosystem (glacial marine fjord), the board used a number of ranking criteria, including whether a study was economically and logistically feasible, and whether the study could be finished in a timely manner. Perhaps most important, the board assessed whether the study questions were answerable, i.e., sensitive enough to lead to detectable effects given inherent variability in park resources. The board also emphasized that studies focusing on individual species should seek to identify physiological or demographic impacts, as opposed to simply documenting changes in species behavior.

Glacier Bay managers implemented a number of these studies, ranging from biological research and modeling to describing visitor experience. All have been designed to directly inform deci-





Photograph by Bill Eichenlaub

**Figure 5.** Haze from a cruise ship smokestack hangs in the air while visiting the Margerie Glacier. There is much uncertainty about whether these stack emissions impact the biological resources in the park, including lichen or water quality. Haze may also negatively influence the experience of other visitors in these wilderness areas.

sions that the superintendent will face as park visitation increases. For example, several studies focus on humpback whales because of their endangered species status, recent evidence of ship strikes in Alaska, and their sensitivity to underwater sounds generated by ships. One effort places NPS observers aboard ships to record the frequency of surfacing by whales and other marine mammals at various distances from the ships (*Figure 8*). These data will be used to estimate the likelihood of marine mammals being struck by ships, and to model the population consequences of any potential increase in the occurrence of

whale-ship collisions. Modeling efforts are also underway to estimate how whales' exposure to ship-generated underwater noise would vary with changes in the number of ships and their transit speeds. Acoustic data (*Figure 9*) are being used to quantify how the underwater soundscape changes in relation to the daily number ships in Glacier Bay. The park and the board have sought to build these studies upon broad-based support and partnerships, and they have actively engaged the cruise industry as the research and monitoring program develops. Partners and participants of these efforts include Cornell University,



National Park Service photograph by Janet Nelson

**Figure 6.** A pair of humpback whales surface dangerously close to the bow of a cruise ship in Glacier Bay. Humpback whales are particularly sensitive to cruise ship traffic because ships produce loud underwater noise which may impede the whales' use of acoustic cues for foraging and communication. Ships have also struck and killed humpback whales in the park.

Cruise West, Holland America, Marine Acoustics, Inc., Moss Landing Marine Laboratory, the National Marine Mammal Laboratory (NOAA), the Naval Surface Warfare Center, Princess Cruise Lines, and R2 Resource Consultants.

Several other monitoring efforts will provide longer term context for biological trends relative to changes in cruise ship entry numbers. These efforts include the long-term monitoring of the humpback whale population since 1985, renewed harbor seal population studies, and new measurements of marine contaminants in intertidal mussels. Some of the monitoring will be conducted by

Glacier Bay scientists (humpback whales, harbor seals) while others are led by scientists from the University of Alaska.

Additionally, the University of Washington has initiated a sociological study to evaluate how cruise ships and other forms of motorized transport influence the quality of visitors' experiences in Glacier Bay. This ongoing study will compare visitor experiences during one- and two-cruise-ship days. Visitors' opinions about cruise ships in Glacier Bay will be measured with a series of interviews and questionnaires targeting different visitor classes such as cruise passengers, charter boat clients,



Photograph by Jamie Womble

Figure 7. Passengers on the bow of a cruise ship observe harbor seals hauled out on the ice flow in Johns Hopkins Inlet. Research elsewhere in Alaska has demonstrated that seals are likely to leave their icebergs and enter the water as a result of encounters with cruise ships, although the physiological 'cost' of the disturbance is unknown. Encounters with harbor seals and other marine mammals are a highlight for visitors and contributes to their experience and perception of Glacier Bay.





Photograph by Scott Gerde

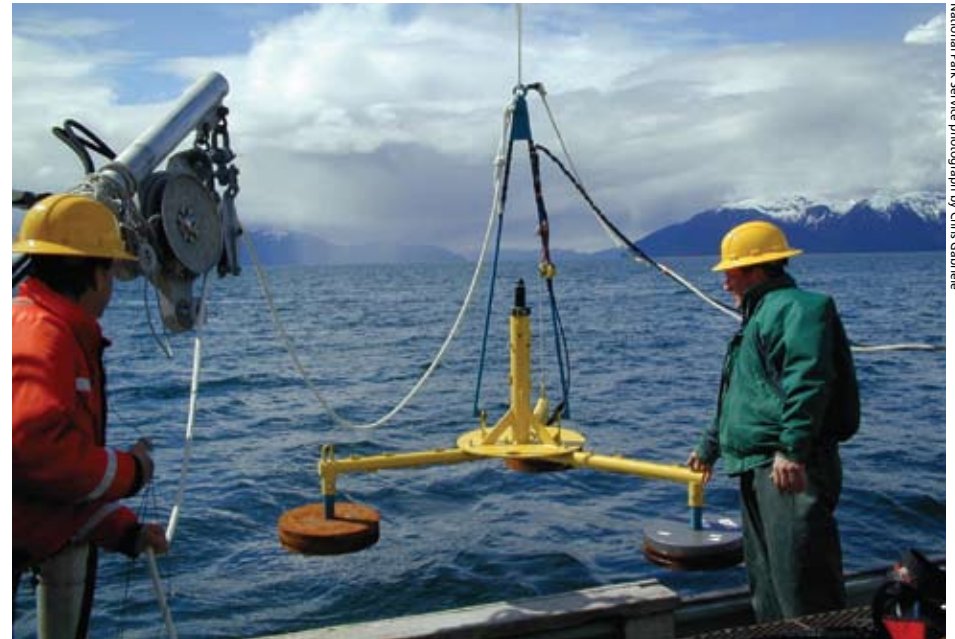
**Figure 8.** An observer stationed at the bow of a cruise ship records encounters with marine mammals in Glacier Bay.

and kayakers.

Finally, in conjunction with the Southeast Alaska Inventory and Monitoring Network, the U.S. Forest Service is spearheading a study to use two types of air samplers to investigate and monitor ambient air quality conditions and sulfur dioxide levels, in accordance with EPA regulations, for areas near the Margerie Glacier where cruise ships congregate and stay for an extended period of time. Passive samplers will yield contaminant concentration data, while through-fall samplers will provide contaminant deposition data. These data will be then compared with a number of other monitoring sites around southeastern Alaska to enable regional

comparisons in air quality.

Covering an array of disciplines and approaches, these studies share the common objectives of generating new insights into the presence and extent of impacts and improving the park's ability to manage both the ships and the resources they encounter. Many of these projects are scheduled for completion between 2008 and 2010. To facilitate the communication of results, a meeting is planned for the winter of 2010 to allow researchers to present their findings to the Science Advisory Board and park management. This research program will not eliminate all uncertainty associated with the potential impacts of cruise ships. But these projects—individually targeted and



National Park Service photograph by Chris Gabriele

**Figure 9.** A hydrophone, shown being deployed near the mouth of Glacier Bay, continuously records how underwater ambient noise varies with changes in precipitation, wind, and vessel traffic.

collectively broad—will greatly improve the park's ability to provide a high-quality experience for visitors, while simultaneously protecting the remarkable natural resources that bring them to the park.

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